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Sinus versus nonsinus tachycardia in the emergency department: Importance of age and heart rate

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Abstract

Background: The emergency department diagnosis of sinus versus nonsinus tachycardia is an important clinical challenge. The objective of this study was to identify subjects with a high prevalence of nonsinus tachycardia.

Methods: Heart rate and cardiac rhythm were prospective reviewed in 500 consecutive patients with heart rate ≥ 100 beats/min in a busy emergency department. A predictive model based on age and heart rate was then developed to identify the probability of nonsinus tachycardia.

Results: As age and heart rate increased, nonsinus tachycardias became more frequent. The probability of nonsinus tachycardia in a subject ≥ 71 years with heart rate ≥ 141 beats/minute was 93%, compared to only three percent in a subject ≤ 50 years with heart rate 100–120 beats/minute. A simple point score system based on age and heart rate helps predict the probability of sinus tachycardia versus nonsinus tachycardia.

Conclusion: Nonsinus tachycardia is significantly more common than sinus tachycardia in elderly patients in the emergency department. The diagnosis of sinus tachycardia becomes much less likely as age and heart rate increase.

Background

Tachycardia is a very common clinical finding in the emergency department (ED), and the differential diagnosis is often challenging. For example, at rapid heart rates, atrial activity may be obscured, and irregularity associated with atrial fibrillation (AF) may be difficult to appreciate. This prospective study evaluates a rapid means of identifying subjects at high risk for nonsinus tachycardia (NST) based on age and heart rate (HR).

First, we assessed the prevalence of NST in subjects presenting to the ED. Then we developed a simple system to help predict the probability of NST based on age and HR. Used as a tool in the evaluation of tachyarrhythmias in the acute setting, this system should help estimate the pre-test probability of a NST and, therefore, aid in the interpretation of the 12-lead electrocardiogram (ECG).

Methods

We prospectively reviewed ECGs from 500 consecutive patients with HR ≥ 100 beats/min (bpm) evaluated in the ED at Beth Israel Deaconess Medical Center over a 9 week period. Approximately 5 tracings with HR ≥ 100 bpm were identified each day. This patient population included both surgical and medical subjects. Patients who presented in cardiac arrest or who required emergent electrical cardioversion were excluded. All ECGs were reviewed by a cardiologist and classified as either sinus tachycardia (ST) or NST. The NST group included AF, atrial flutter, paroxysmal supraventricular tachycardias (PSVTs) including atrial tachycardias and indeterminate nonsinus rhythms. No ventricular tachycardia was observed in the population. No subject was excluded. If multiple tracings were obtained, the single tracing with maximum HR was selected.

Statistical Analysis

To develop a simple screening system to estimate the likelihood of ST versus NST, we used the following procedure. Subjects were classified into three age categories: ≤ 50, 51–70, and ≥ 71 years. These groups were subclassified into three HR categories: 100–120, 121–140, and ≥ 141 bpm. To derive and then validate the statistical model, logistic regression models were developed from 349 randomly selected patients from the entire cohort of 500 patients. The models were then tested using a validation set of the remaining 151 patients. These models established HR and patient age as highly significant ($p < 0.0001$) predictors of NST.

The predictive model was developed using variables representing each of the age and HR groups in multivariate regression analysis. Dividing the coefficients of the regression model to the by 0.5 and rounding to the nearest integer created a simplified point score index. Model fit and discrimination were evaluated [1]. Statistical analyses were performed using SAS for Windows version 6.12 (SAS Institute, Cary, NC). Frequencies were compared using χ^2 or Fisher's exact tests, and a 2-sided p-value <0.05 was required for statistical significance.

Results

The mean age of the population was 65 years (SD +/-19 years; range 14–103). Sinus tachycardia was the most common rhythm overall, present in 70% of subjects. Of the 30% of subjects with NST, AF was the most common arrhythmia and accounted for 69% of such cases. Five percent of subjects were in PSVT and two percent were in atrial flutter. No ventricular tachycardia was identified in this cohort.

For all age groups, as HR increased, NST became more frequent. For all HR categories, as age increased, NST also became more frequent. Only one percent of subjects with age ≤ 50 years and HR 100–120 bpm were in NST, while 88% of subjects with age ≥ 71 years and HR ≥ 141 bpm were in NST ($p < 0.0001$). Similarly, only 18% of patients with HR 100–120 bpm were in NST, compared to 79% of patients with HR ≥ 141 bpm ($p < 0.0001$) (Table 1).

There were no significant differences in the prevalence of NST between the derivation and validation sets. The point score for each patient was computed by assigning 0 points for age ≤ 50 years, 3 points for age 51–70 years, and 5 points for age ≥ 71 years. Subjects were also given 0 points for HR 100–120 bpm, 3 points for HR 121–140 bpm, and 8 points for HR ≥ 141. The sum of the points for age and HR, ranging from 0 to 6.5, placed the patient in one of seven risk factor categories.

The predicted probabilities of NST derived from the final multivariate logistic regression model are given in Table 1. Comparison of the predicted prevalences of NST from the regression model with the observed prevalences in the derivation and validation sets demonstrated a good fit (Hosmer-Lemeshow Goodness-of-Fit χ^2 p-value of 0.92 and 0.82 for the derivation and validation sets, respectively). The discriminatory function, or the ability of the model to predict NST, was good with the area under the receiver operating characteristic curve of 0.8 for both the derivation and validation sets.

Discussion

The central finding of the study was the very high prevalence of NST in elderly subjects presenting to the ED with rapid HR. Analyses of arrhythmias in elderly patients admitted to the emergency or acute geriatric units have estimated the overall prevalence of supraventricular arrhythmias to be 20–30% [2,3]. We found NST in 60–90% of patients ≥ 71 years with HR >120 bpm in an acute setting.

The most common NST was AF, accounting for 69% of cases. AF was found in almost 20% of the entire study group, a much higher prevalence than reported in other non-acute populations [4,5]. The very high prevalence of AF in our ED population may identify a more severely ill patient subset with more concurrent medical problems. Of note, all-cause and cardiovascular mortalities in the elderly with AF are doubled compared to those without AF [6–8].

Our data show that the diagnosis of ST becomes less likely as HR increases. While ST is the most common arrhythmia in young patients, NSTs are more common in elderly patients. Based on our ED data, more than 80% of subjects ≥ 51 years with HR ≥ 141 bpm can be expected *not* to be in sinus rhythm. Conversely, a subject ≤ 50 years with

Table 1: Prevalence and Predicted Probabilities * of Nonsinus Tachycardia (NST) Based on Age and Heart Rate (HR)

Age (years)	Heart Rate (beats/min)		
	100–120 (0 Points)	**121–140 (3 Points)**	**≥141 (8 Points)**
<50 (0 Points)	**0 Points**	**3 Points**	**8 Points**
Predicted Probability of NST	3%	13%	62%
Observed Probability of NST	1% (1/77)	13% (4/30)	67%(6/9)
51–70 (3 Points)	**3 Points**	**6 Points**	**11 Points**
Predicted Probability of NST	13%	39%	86%
Observed Probability of NST	12%(14/114)	40%(8/20))	75%(15/20)
>71 (5 Points)	**5 Points**	**8 Points**	**13 Points**
Predicted Probability of NST	28%	62%	93%
Observed Probability of NST	30%(50/165)	59%(20/41)	88(21/24)

*Probability of NST is given by the equation: $\ln(p/1-p) = [-3.536 + (1.099 \times \text{score}) - (0.0235 \times \text{score}^2)]$

HR ≤ 120 bpm has a 99% probability of having ST. These findings are consistent with the observation that the sinus node's ability to generate rapid rates decreases with increasing age, making rapid sinus rhythms quite unlikely at advanced ages. There is a decrease in maximal HR that occurs with physiological aging which may be due to a combination of factors, including intrinsic sinus node disease, ischemia, and alterations in afferent baroreceptor sensitivity and autonomic input and responsivity. The inability to augment heart rate appropriately in response to exercise or physiologic stress has been termed chronotropic incompetence and may be present in 40–70% of elderly subjects [9,10]. More importantly, nonsinus tachycardias become more frequent as patients age due to the increased prevalence of structural heart disease in the elderly population [11,12]. While older patients frequently come to the emergency department primarily with cardiovascular symptoms, younger patients often present to the ED for noncardiac reasons and may be expected, therefore, to have a higher prevalence of sinus tachycardia.

Finally, we note that this study did not address the role that specific disease processes made in precipitating or exacerbating NST. For this reason, the ability to generalize these findings to otherwise healthy, elderly patients in the outpatient setting is limited.

Conclusions

Based on our ED findings, physicians caring for subjects in the ED should have a very high suspicion for a primary NST, rather than a secondary ST, particularly in the elderly, tachycardic subject. Use of our a simple table (or score) incorporating age and heart rate may alter the pretest probability of NST for a given patient, aiding in the acute interpretation of the 12-lead ECG. Such assessments of elderly patients in the ED may also have implications for the rapid triage and definitive treatment of these patients.

Author's Contributions

DP performed the data collection, ECG analysis, and manuscript preparation.

KH and AP performed the statistical analysis and assisted in manuscript preparation.

PZ assisted in study design, ECG analysis and manuscript preparation

AG envisioned the project, assisted in study design, manuscript preparation and ECG analysis.

All authors have read and approved the final manuscript.

Competing Interests

None declared.

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